The Association between Work Productivity and Physical Activity among Singapore Full Time Employees

By

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Date: March 26, 2014
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Eric Andrew Finkelstein, Supervisor

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David Boyd

Thesis submitted in partial fulfillment of
the requirements for the degree of Master of Science in Duke Global Health Institute
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ABSTRACT

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Abstract

Low work productivity has caused large indirect cost to many employers. Evidence shows that physical activity can improve health status, thus enhancing work productivity. In view of the benefits of physical activities, the World Health Organization (WHO) issued a guideline on age-specific physical activity standards in 2010. According to the guideline, two weekly physical activity standards (the WHO standard and the WHO additional standard) have been introduced in order to prevent non- communicable disease and relieve mental pressure.

In this study, the association between work productivity and physical activity has been explored. The work productivity is measured by presenteeism and absenteeism together. Presenteeism implies a situation where a mentally or physically sick employee attend to work despite a medical illness that makes their job performance sub-optimal. It is recorded as a self-reported percentage of work efficiency loss in the study. Absenteeism implies having work absence because of medical condition. It is recorded as whether participants have medical absence in the past week. 928 valid responses from Singapore full-time employees have been analyzed using logistic models.

Results show that participants who had not met the WHO additional standard are less likely to have medical absence ($OR=2.51$, $P<0.05$). The longer time spent on physical activity is associated with lower work productivity ($OR=1.001$, $P<0.05$). I also found that the more frequent individual keeps healthy lifestyle, the lower presenteeism and absenteeism one will have.

The findings could be explained by several reasons. First, physically active participants have higher chance of getting physical injuries, leading to medical absence from work. Secondly, participants who had met the WHO additional standard are more likely to have lower income. Because of the labor leisure tradeoff theory, people who have lower income are less incentivized to trade leisure time for work. Therefore, the participants who had met the WHO additional

standard have a lower medical absence rate. Thirdly, findings show that frequent healthy lifestyle is associated with higher work productivity. However, People who had met the WHO additional standard are less likely to have a frequent healthy lifestyle due to the lower social and economic status they have. Therefore, even though they have longer time spent on physical activity, the work productivity is still low. Lastly, employees in Singapore ask for medical absence only due to urgent and serious medical conditions and such urgent and serious medical conditions cannot be prevented by physical activities.

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Acknowledgement

Foremost, I would like to express my sincere gratitude to my advisor Professor Eric Andrew Finkelstein for the continuous support of my Master's study and research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

Besides, I would like to thank the rest of my thesis committee: Professor David L Boyd and Professor Manoj Mohanan for their encouragement and insightful comments.

My sincere thanks also goes to colleagues from Duke-NUS: Junxing Chai, Aarti Sahasranaman, and Janice Tan, technical support Joe Egger from Duke Global Health Institute, and my classmates Mirna Mun and Stephen Kimani who helped me with language revision.

Last I want to thank my family and Claire Mengjiao Wu for their both mental and physical support in my finishing the thesis.

Background：

Low work productivity has caused a large indirect cost to many employers all over the world.[1] According to the literature review, there are two indicators to measure the work productivity: absenteeism and presenteeism. The most common measurement of the workplace productivity is the absenteeism defined as the time missed from work because of illness or other medical conditions. It is calculated that the median cost for the absenteeism is $468 per year for an individual worker. Annually, low productivity is estimated to cost as much as $21,000 in small enterprise and up to $2.5 billion in big companies[2] "Presenteeism" is originally conceptualized by a UK psychologist, Professor Cary Cooper from the University of Manchester[3]. It refers to a situation where a mentally or physically sick employee goes to work despite a medical illness that makes their job performance sub-optimal[3]. One study examining the burden of cost for different health conditions indicated that the presenteeism related cost is greater than the absenteeism related cost in the United States. [4]

Physical inactivity is the 4th leading risk factor for global mortality[5]. Studies have found that compared with less physically active adults, people who take more physical activities have a lower all-cause mortality, as well as mortality from causes such as coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon and breast cancer, and depression[5]. People who are more physically active, are likely to have a lower risk of vertebral fracture, higher level of cardiorespiratory and muscular fitness, and are more likely to maintain optimal weight[6]. In addition, physical activity has been shown to relieve mental pressure, stress and anxiety, thus improving the productivity of employees during the work[7].

In view of these benefits of physical activity on the potential to prevent non-communicable diseases (NCDs), the World Health Organization (WHO) issued guidelines on an age-specific recommended physical activity in 2010. According to these guidelines, in order to

prevent communicable disease and relieve mental pressure, adults aged 18-65 should meet the WHO general standard, which is engaging in at least 150 minutes of moderate physical activities, 75 minutes vigorous activities, or an appropriate combination of both per week. Physical activities may include recreational, transportation, and/or occupational occurring in the context of daily, family and communal activities. Aerobic physical activity should be performed in bouts of at least 15 minutes continuously. For additional health benefits, adults should meet the WHO Additional Standard, increasing their physical activity to 150 minutes at vigorous level, or 300 minutes at moderate level, or an equivalent combination per week.[8] There are evidences supporting the WHO general standard in terms of improving health status, while lacking sufficient evidence to identify specific benefits of the WHO Additional Standard.

There are many reasons for low work productivity and health status is regarded as one of the main contributors [1, 9]. Physical activities can improve the health status, therefore increasing the work productivity. Many studies have evaluated the relationship between physical activity and work productivity.[10, 11] Jacobson (2001) et al studied the relationship between the frequency of aerobic activity and the illness-related absenteeism and found that non-exercisers are more likely to be absent (defined as a 7+ days/year absence) compared to regular exercisers.[12] Proper (2005) et al reported a negative dose- response relationship between vigorous physical activity and medical absent days. The threshold frequency is three times (20-mins long) per week. He also provided evidences to show that moderate physical activities are not significantly associated with medical absence.[13] Bernaards (2004) et al studied 700 individuals and found that higher level of physical activities is related to the higher quality of work performance which is measured by work loss days, quality of work, extra effort exerted and interpersonal relationship.[14] Lahti (2010) found that the physical activity is significantly negatively associated with sickness absence among male participants [15]. Block et al (2008) designed a randomized control trial to evaluate the effectiveness of a physical activity promotion

intervention in California. The results of the intervention shows that the presenteeism- difficulties concentrating because of depression/ anxiety and back pain- did not change between intervention and control groups over the study period (OR=1.00, p=0.04)[16], suggesting that other factors are at play in the relationship between work productivity and physical activity. Furthermore, he argued that physical activities together with nutritional improvement, smoking control, and psychological counseling as a package can improve the psychological well-being of employees during the work thus decreasing the presenteeism [17, 18].

This paper has made several unique contributions based on previous studies. Firstly, this is one of a few papers combine the presenteeism with the absenteeism as the productivity measurement. In most of the previous studies, authors either used presenteeism or absenteeism to measure the work productivity. Secondly, since the issuance of the WHO standards, this paper one of very few articles testing whether WHO issued physical activity standards are associated with work productivity. In this study, WHO additional standard (300 minutes moderate physical activity/ week) and WHO general standard (150 minutes moderate physical activity/ week) are tested separately. Thirdly, most of the studies were done focusing on country not in Asia, leaving no evidence available for health promotion programs in Asian countries. However, due to the difference in population health status, for example, in general, lower mean and median BMI has been found among Asian populations compared with western populations, and in work ethics, for example employees in Asia are more likely to have longer work hours and work overtime on the job, it is necessary to test the association in particular under Asian context. [19] [20]

1. *Hypothesis*

1) Workers in Singapore who had met WHO physical activity standards (both the general standard and additional standard) have significantly higher work productivity than employees who had not;

2) More physical activity is associated with higher work productivity among workers in Singapore;

2. Specific Aim and Objectives

1) To test if participants who had met the WHO general standard are less likely to be absent from work because of medical conditions;
2) To test if participants who had met the WHO general standard have lower presenteeism because of medical conditions;
3) To test if participants who had met the WHO additional standard are less likely to be absent from work because of medical conditions;
4) To test if participants who had met the WHO additional standard have lower presenteeism at work because of medical conditions;
5) To test if more physical activity is associated with lower presenteeism at work because of medical conditions;
6) To test if more physical activity is associated with being less likely to be absent from work because of medical conditions.

Measures

1. Data Collection

The data of this research is from the primary study- "*A Randomized Trial of Economic Incentive to Promote Physical Activity Among Full Time Employees (TRIPPA)"* in Singapore (PI: Eric Andrew Finkelstein, PhD. Duke-NUS Graduate Medical School, Singapore), aiming at accessing the uptake, effectiveness, and cost-effectiveness of a scalable incentive-driven worksite-based physical activity program both with and without incentives.

The study target population is full-time employees aged between 21 and 65 who are citizens or permanent residents of Singapore. Full time employees should be those who work for

an employer in return for regular wages or salaries for 35 hours per week or more. Before administrating the survey, 1,000 nationally representative samples were purchased from the Singapore Department of Statistics according to the target population criteria. The local research agency sent a research invitation letter containing the study detail to the representative samples. After a two-week opt-out period, interviewers from the research agency visited the participants who were willing to enroll in the research in their households to explain broad objectives of the study, to collect general information, as well as asking participants to sign the IRB-approved consent form.

Before the official interview, participants under the following conditions were excluded from the study.

a. Individuals who cannot read English, Mandarin, Malay or Tamil or speak major dialects.

b. Individuals who are cognitively impaired or are unable to communicate verbally.

c. Individuals who cannot do 10 minutes of aerobic activities without stopping (unless due to a short-term medical condition such as an injury)

Interviewers revisited qualified subjects in their home upon receiving the consent form to conduct the interviews. The interviews had been translated in English, Mandarin, Malay, Tamil and other major dialects according to the subjects' needs. To ensure sufficient responses, small financial incentives for participants who completed the survey were offered. Interviewers made multiple visits to the same address to maximize the response rate.

2. *Data Analysis*

In this study, the productivity of work is measured by "Presenteeism" and "Absenteeism". Presenteeism is defined as the self-reported percentage of work efficiency loss on the job because of illness or other medical conditions, and absenteeism is defined as whether employees had medical absences during past seven days. Both presenteeism and absenteeism are measured by

questions from the Work Productivity and Activity Impairment Questionnaire: General Health (WPAI-GH). Specifically, the value of presenteeism is collected from the answer to the question in the survey "how much health problems affected productivity while working". Participants are required to give a self- reported value with 10% interval from 0%, meaning health problems have no influence on my work productivity, to 100%, meaning health problems completely prevented individuals from work.

Absenteeism is defined as percentage of time missed from work. In this study, "Absenteeism" is a binomial variable recording if individuals had missed from work because of health problems. In the survey, participants were asked "in the past 7 days, how many hours did you missed from work". According to the preliminary analysis, I found most of the participants (94%) had not been absent from work for the past seven days, and 2% participants reported being on a medical absence for less than 3 hours in the past week, leaving very few samples that could be tested and compared for being absent for more than 3 hours. Besides, there is no significant difference of health status between individuals who are absent for 3 hours and 2 (or 1) hours. Most of the reasons why individual who are absent for 3 hours, instead of 2 hours are due to transportation related reasons and company administrative related reasons instead of health related reasons. Therefore, in this study, I defined the absenteeism as whether individuals had medical absence from work, or not. The absenteeism is coded as one for participants who had reported medical absence in the past seven days and zero for participants who had not reported any absences.

The independent variable is the time spent on physical activities which is measured by the International Physical Activity Questionnaire (IPAQ). IPAQ questions collect data of physical activities from three domains: activity at work, activity when travelling to and from places, and recreational activities. Participants were asked to consider in the past average week, how many days per week they participated in moderate and vigorous physical activities, and how many hours and minutes on average they participated in physical activities in three domains. There are

specific definitions to distinguish the moderate physical activity to the vigorous physical activity. For example, the vigorous activity in work is defined as activity that causes large increases in breathing or heart rate like carrying or lifting heavy loads for at least 10 minutes continuously, and the moderate physical activity is defined as activities that cause small increase in breathing or heart rate such as carrying light load for at least 10 minutes. The vigorous recreational activities is defined as activities that cause large increase in breathing or heart rate like running, football, or kick-boxing for at least 10 minutes continuously; the moderate recreational activities are defined as activities that cause small increase in breathing or heart rate such as brisk walking, cycling swimming, volley ball for at least 10 minutes continuously. The survey has not differentiated the physical activity in the travelling domain. Since physical activity when travelling mostly includes walking, jogging and smooth biking, which will not largely cause increasing breathing or heart beats, it is counted as moderate physical activities.

As for the independent variable, I generated two dummies to measure if one had met the WHO general standard and if one had met the WHO additional standard. All of the weekly physical activity time will be added up from three physical activity domains and two different intensity levels. According to the WHO, 1 minute vigorous physical activity will be counted as 2 minutes moderate physical activity. The WHO general standard is 150 minutes of moderate physical activities per week, or 75 minutes of vigorous physical activities, or the combination of both. The WHO additional standard is 300 minutes moderate physical activities per week, or 150 minutes vigorous intensity physical activities, or the combination of both moderate and vigorous physical activities. Also, there is a continuous variable measuring the total amount of physical activities per week for every individual. To be constant, in this paper the physical activity will be reported only at the moderate physical activity level and all time spent on intensive physical activities will be transferred to moderate level with the WHO ratio of 1:2.

To test hypothesis one, the Logistic model is applied to determine the association between WHO standards (both the general standard and the additional standard) and the absenteeism. Sensitivity analysis is performed using Poisson model. The Ordered Logistic model will be used to evaluate the association between WHO standards and the presenteeism. To test the hypothesis two, I used the continuous variable which contains the time spent on physical activities. The logistic model is used to test the association between the time spent on physical activities and the absenteeism. Sensitivity analysis is performed using Poisson model. The Ordered Logistic model is used to evaluate the association between the physical activity time and the presenteeism. As there are articles suggesting that physical activities cannot improve the work productivity without all round healthy lifestyle change, in hypothesis two, I further tested if those who maintain a healthy lifestyle frequently are associated with having higher work productivity [17, 18]. The healthy lifestyle variable is measured by the question in the survey that "Throughout your adult life, which of the following best describes your approach to managing your health". There are five options "I maintain a healthy lifestyle all the time/ most of the time/ sometimes/ never."

In above models, several confounding variables are controlled in the model. Age is one of the confounders because according to Huang et al, aged employees (>40 years old) are more physically inactive than people younger than 40 years old, and they feel harder to concentrate on work because of higher prevalence of chronic diseases among this population [21]. Whether living with children, gender and occupation type (labor worker or office worker), and family income are also included as confounders in the model according to similar studies that has been done elsewhere [15]. To avoid the income bias in the survey, I used the residence type as the vector. In Singapore, higher income employees are living in a more spacious residence.

All analysis are performed using STATA version 11as the statistical analysis software (StataCorp. 2009. Stata Statistical Software: Release 11. College Station, TX: StataCorp LP). For

all statistical determinations, significance levels are established at 95% level. The Odds Ratio for Logistic Models and Incidence Rate for Ordered Logistic Models are reported in the paper.

Results:

1. *General Information*

1.1 Social, Economic and Demographic Factors

There were 950 employees participated in the survey among whom 56.76% are male participants and 43.26% are female participants. The youngest participant is 20 years old and the oldest is 68 years old. As there are only 10 participants elder than 64 years old which gave me limited power to test the validity of WHO recommendations for the >64 age group, I censored out those participants in data analysis. The age groups are categorized with 10 years interval shown in table 2. Respectively, there are 14%, 28.42%, 30.11%, 26.32% and 1.16% participants in 18-28, 29-38, 39-48, 49-64 and >64 age groups. As Singapore is an immigrant country, employees are from diverse ethnic backgrounds. In my research, most of participants are Chinese ethnicity (68%). The three largest ethnicity groups in our study population are Chinese, Malay (12.52%) and India (14.63%).

Table 1: Gender distribution of the study participants

Gender	%	Frequency
Male	56.74%	539
Female	43.26%	411
Total	100%	950

Table 2: The age distribution of study participants

Age	%	Frequency
18-28	14	133

29-38	28.42	270
39-48	30.11	286
49-64	26.32	250
>64	1.16	11
Total	100	950

Concerned about the bias of the self-reported individual and family income, the variable measuring types of residence is used as the vector to indicate participants' income. In Singapore, the larger size of the residency is associated with higher income[5]. Those who live in condos have the highest income. According to table 4, most of the participants (51.85%) are living in the apartment with 3-4 rooms, and very few (5%) are living in the apartment with 1-2 rooms. There are 22.91% participants living in the condos.

Table 3: The type of residence, apt: apartment

	Frequency	%
1-2 rooms apt	48	5.07
3-4 rooms apt	491	51.85
>=5 rooms apt	191	20.17
Condo/house	217	22.91
Other	3	0.22
Total	947	100

Office workers and labor workers constituted the study population. I categorized all self-reported occupations into two types-- office work and labor work, according to the estimation of the amount of physical activities required in the job. Office workers include

professional and technical, higher administrator occupations, and clerical occupations. There are in total 594 office workers, among whom 285 professional and technical employees take the largest share as 30% of the total study population. The labor workers include service occupations, sales occupations, workers, and farmers. There are 334 labor workers in the study, among whom 117 service occupation participants take the largest share. In general, 63.5% of the study participants are labor workers and 36.42% of the study participants are office workers.

Table 4: The occupation of participants

Occupations		n	%	n	%
Office work	Professional and technical (e.g. Doctor, teacher, engineer, artist)	285	30	594	63.58
	Higher administrator occupations (e.g. Banker, executive in big business, high government official, union official)	187	19.68		
	Clerical Occupations (e.g. Secretary, clerk, office manager, book keeper)	132	13.89		
Labor work	Service occupations (e.g. Police officer, waiter, caretaker, barber, armed forces)	117	12.32	334	36.42
	Sales occupations (e.g. Sales manager, shope owner, shop assistant, insurance agent)	87	9.16		
	Skilled worker (e.g. Foreman, motor mechanic, printer, tool and die maker, electrician)	37	3.89		

	Semi-skilled workers (e.g. Bricklayer, bus driver, cannery worker, carpenter, sheet metal worker, baker)	47	4.95		
	Unskilled worker (e.g. Laborer, security personnel, unskilled factory worker)	58	6.11		
	Farm worker (e.g. Farmer, farm labor, fisherman)	0	0		

1.2 Participants' Physical Activities Status

There are 927 out of 950 participants reported valid data of their time spent on physical activities every week. Ten participants have been censored out because their ages are elder than 64 years old. Another 13 participants are excluded because they reported the total time spent on physical activities per day is more than 24 hours which is not realistic. The following table shows the mean, minimum, maximum and the standard deviation of the time spent physical activities in three different domains respectively.

Table 5: the Physical Activity Status

Work domain	**mean**	**min**	**max**	**SD**
Vigorous	91.36	0	4620	394.29
Moderate	132.5	0	4320	494.57
Travel domain				
	296.64	0	3600	211.84
Recreational domain				
Vigorous	47.04	0	2475	131.94
Moderate	82.75	0	2475	183.28

Total time				
Total moderate time	511.49	0	4860	731.87
Total vigorous time	135.99	0	4620	419.26
WHO total time per week	784	0	9345	1213
The unit for the table is minutes per week at the moderate level				

According to table 6, participants have spent on average 91 (SD=394) minutes on vigorous physical activities during work per week, 132 (SD=494) minutes on moderate physical activities during work per week, 296 (SD=211) minutes on physical activities in travel, 47 (SD=131) minutes on vigorous physical activities during recreational time and 82 (SD=183) minutes on moderate physical activities during recreational time. The total time spent on physical activities per week among 927 valid observations is 784 (SD=1213) on average.

The total physical activity time has been categorized into 16 categories with 100 minutes interval. There are 178 participants reported that their weekly physical activity time is less than 100 minutes (around 15 minutes per day) and there are 136 participants reported that their weekly physical activity time is more than 1600 minutes (3.8 hours per day). There are 247 (26.2%) participants had not met the WHO general standard and 682 (73.8%) that had met the WHO general standard. There are 418 (45%) participants who had not met the WHO additional standard while 429 (55%) participants who had met the WHO additional standard. In between, there are 171 (19.3%) participants had met the WHO general standard but had not met the WHO additional standard.

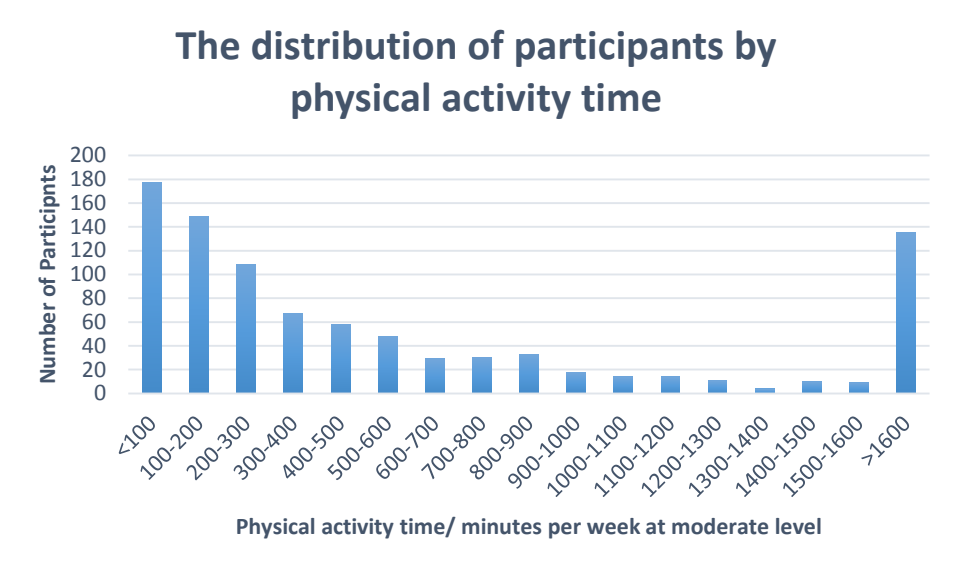

Figure 1: The distribution of WHO total physical activity time

1.3 Work Productivity

Table 6: The Presenteeism and Absenteeism

	mean	min	max	SD
Presenteeism	8.75%	0	1	0.18
Absenteeism	6.27%	0	1	0.23

The presenteeism is the self-reported rate from 0-100% with 10% interval indicating how much work efficiency had been impaired by health problems. 100% means health problems completely prevented people from working while 0% means health problems have no effect on their work. The mean efficiency impaired at work because of health conditions is 8.75% (SD= 0.1787). There are 635 (68.4%) participants reported the work efficiency loss is 0 and 82 participants reported different levels of work efficiency loss ranging from 10% - 100% because of medical conditions

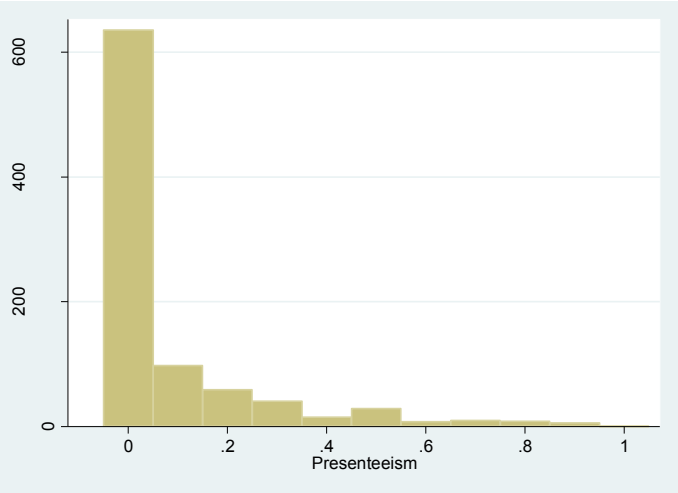

Figure 2: The Distribution of Population by Presenteeism

The absenteeism indicates the likelihood of employees having medical absence. According to the survey, 874 (94%) participants reported that during the past week, they had no medical absence because of health problems. Only 46 (6%) participants reported they had medical absence during the past seven days and 15 (2%) participants reported more than 3 hours medical absence last week as shown in graph 3. The likelihood of medical absence among the study population is 6.27% (SD=0.23) on average.

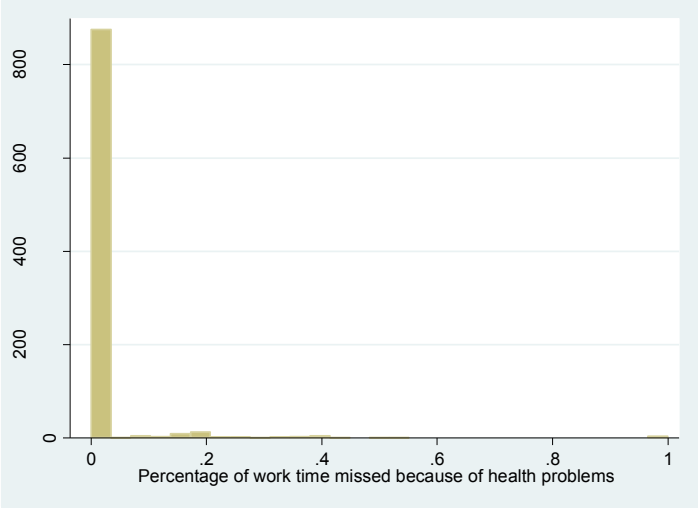

Figure 3: the Distribution of Population by Absenteeism

1.4 Health Status

According to graph 5, 187 (20.17%) participants reported that they maintained healthy lifestyle almost all the time, 358 (38.4) participants reported they maintained healthy lifestyle most of the time, 334 (36.03%) participants reported they maintained healthy lifestyle sometimes and only 50 (5.39%) participants who never maintained healthy lifestyle.

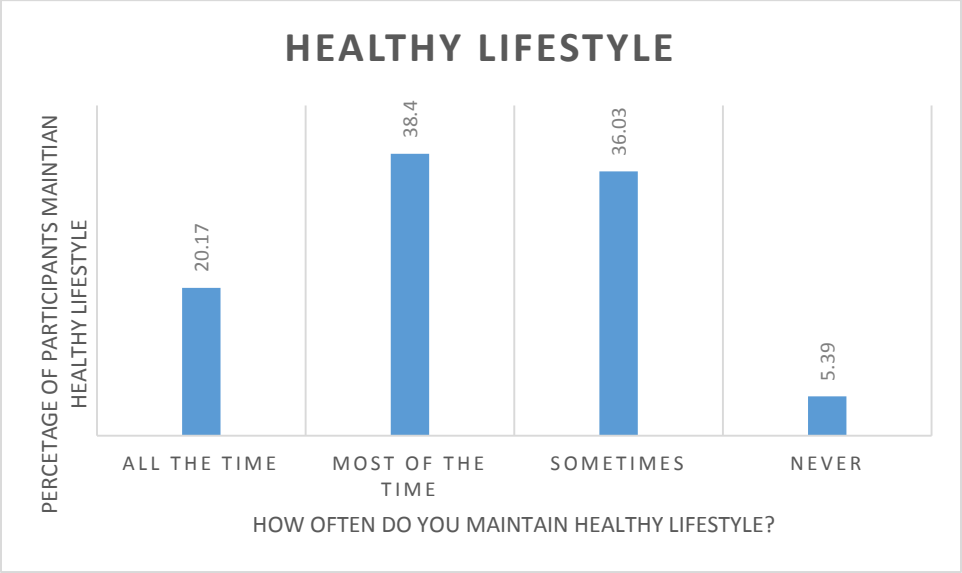

Figure 4: the health lifestyle

2. *Cross Tabulations*

2.1 Physical Activities – Occupation type

Table 7 Time spent on physical activities across occupation type

Occupation Type	Number of Participants	Mean time spent physical activities (minutes/ week)	Standard Deviation
Office Worker	593	596.9	914
Labor Worker	334	1115.3	1561.3

According to table 7, office workers spend on average 596.9 minutes on physical activities, 261 minutes of them are contributed by moderate level physical activities. Labor workers spent twice as much time as the office workers on physical activities. 326 minutes out of

1115.3 minutes are contributed by moderate level physical activities. In general, labor workers have much more time spent on physical activities and they have more percentage of time spend on vigorous physical activities.

2.2 WHO Standards – Occupation type

Table 8 occupation types across WHO standards

Occupation Type	Have Met the WHO General Standard	Have not Met the WHO General Standard	Total	Have Met the Additional WHO Standard	Have Not Met the Additional WHO Standard	Total
Office Worker	30%	70%	100%	50%	50%	100%
Labor Worker	22%	78%	100%	36%	63%	100%

According to table 8, for office workers, 30% of them had met the WHO general standard and 70% of them had not met the general standard, 50% of them had me the additional WHO standard and 50% of them had not met the WHO additional standard. For labor workers, 22% of them had met the WHO general standard and 78% had not met the WHO general standard. 36% of them had met the additional WHO standard and 63% of them had not met the WHO additional standard.

2.3 Work Productivity – Occupation type

Table 9: Work Productivity across Occupation Types

Occupation Type	Mean Absenteeism value	Mean Presenteeism value
Office workers	0.059 (SD= 0.239)	0.77 (SD= 1.69)

Labor workers	0.057 (SD=0.232)	1.06 (SD= 1.93)

The mean absenteeism value for office workers is 0.059 (SD=0.239) and the mean presenteeism value is 0.77 (SD=1.69). The mean absenteeism value for office workers is 0.057 (SD=0.232) and the mean presenteeism value is 1.06 (SD=1.93). According to the result, there is no significant difference of the likelihood of having medical absences. However, during the work, labor workers on average have more work efficiency loss due to health problems compared with office workers.

2.4 WHO Standards- Demographics

There are slight difference of social demographic backgrounds across the WHO standard. The median salary for participants who had met the additional standard is $3000-$3999 per month and $4000-$4999 per month for the counterpart group. The education status for two groups are shown in table 8, that 42% participants who had not met the WHO additional standard hold college or higher degrees while 31% participants who had met the WHO additional standard hold college or higher degrees. The average age for those who had not met the additional standard is 41.23 (SD= 10.07) and 41.03(SD= 11.11) among those who had met the additional standard. 52% of the participants who had not met the additional standard are male and 60% who had met the additional standard are male. There are 57% of the participants who had not met the additional standard said they were living with their children compared with 66% in the counterpart group. There are 52% participants who had met the WHO additional standard work as an office worker and there are 74% participants who had met the WHO additional standard work as an office worker. Participants who had met the WHO additional standard are more likely to be a male, working as a labor worker, owning lower income, and receiving lower educations.

Table 10: The Education Status across the WHO Additional Standard

Education Level	Had met the WHO additional standard		Had not met the WHO additional standard	
	Number of Participants	Percentage	Number of Participants	Percentage
Primary Education or less	46	9	21	5
Secondary Education	177	34	136	32
High School or Professional Diploma	118	23	83	20
College	106	20	121	29
Graduate Study or above	60	11	54	13

2.5 WHO Standards- Work Productivity

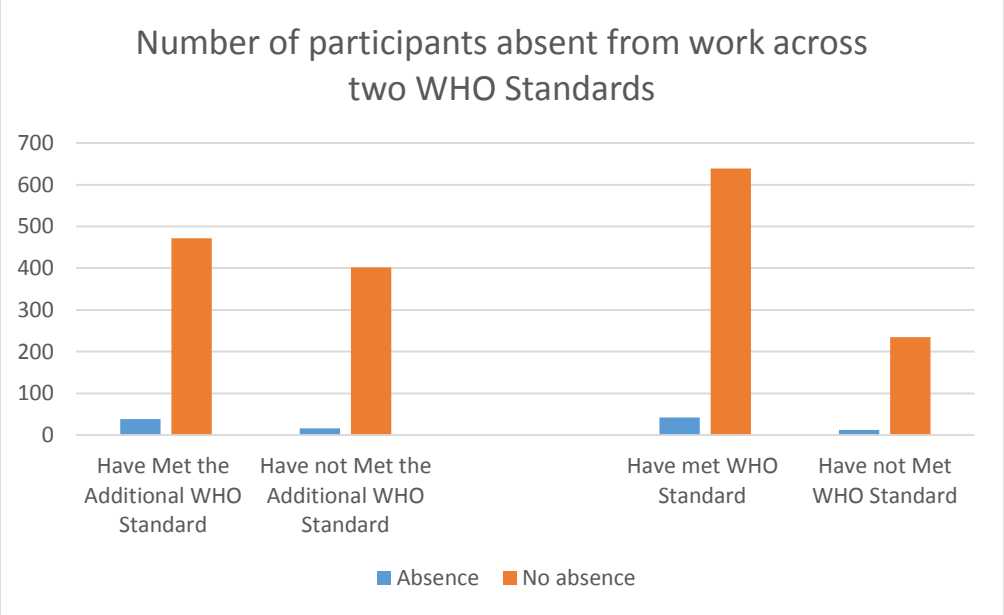

Figure 5: Work Absence by WHO Standards

There are 247 participants failed to meet the general WHO standard, and 95% of them had no self-reported medical absence last week. There are 681 participants achieved the WHO general standard, and 93% of them had no self-reported medical absence last week.

Among participants who had not met the WHO additional standard, there are 402 (96%) people had not been absent from work because of medical conditions, and there are 16 (3.83%) people had asked for medical absence. Among participants who had met the WHO additional standard, there are 472 (92.55%) participants had not asked for medical absence during the past week while 38 (7.4%) participants had medical absence.

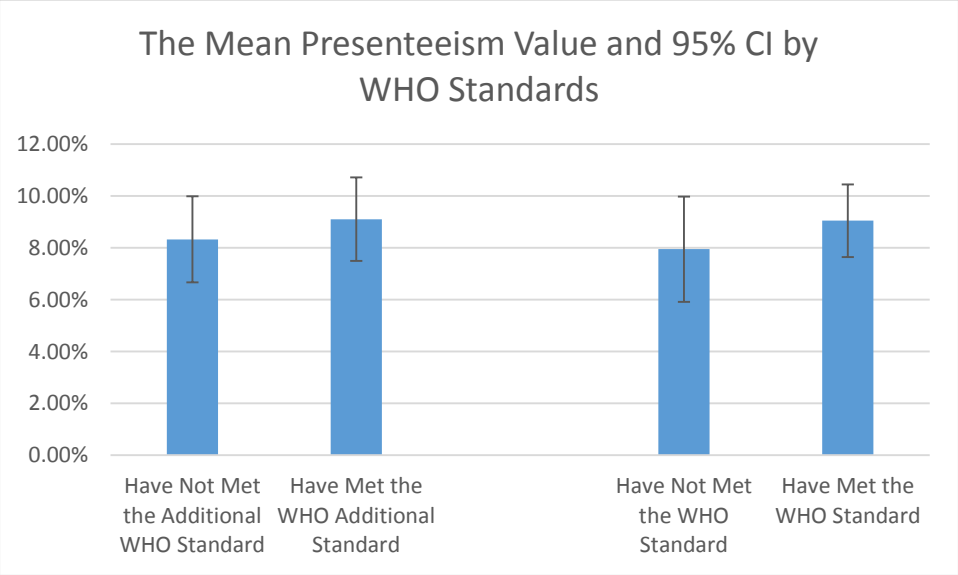

Figure 6: The Mean Value of the Presenteeism and 95% CI by WHO Standards

According to graph 7, for participants who had not met the WHO additional standard, they reported on average 8.33% (SD=17%) work efficiency loss because of medical conditions and for participants who had met the WHO additional standard, they reported on average 9.11% (SD= 18%) work efficiency loss because of medical conditions. For participants who had not met the WHO general standard, the reported mean presenteeism value is 8% (SD= 16%) and for participants who had met the WHO general standard, the reported mean presenteeism value is 9% (SD=18.5%). The difference observed in the cross tabulation is very minor.

2.6 Physical Activity- Presenteeism

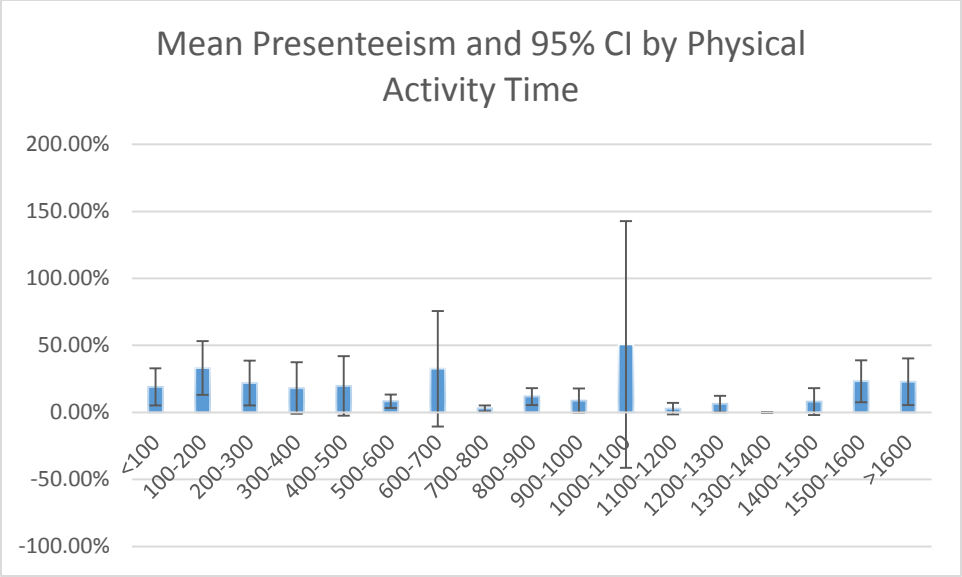

Figure 7: The Mean Presenteeism by Physical Activity Time with 95% CI

According to graph 8, the longer time spent on the physical activity is not associated with consistent changes in the presenteeism value. The large standard deviation caused the presenteeism value vary widely.

2.7 Physical activity- Absenteeism

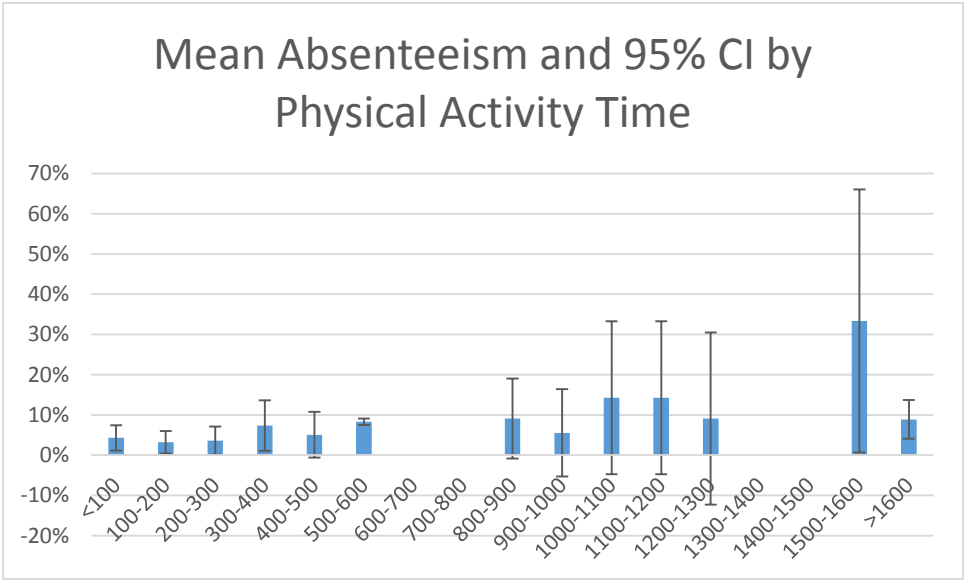

Figure 8: The Mean Absenteeism by Physical Activity Time with 95% CI

The above graph 8 shows the value of absenteeism and its 95% confidence interval with the categorical increase of the physical activity time. Since the variance is too large, we cannot observe a significant difference of absenteeism between different levels of physical activity time according to preliminary cross-tabulations.

2.8 WHO Standard – Healthy lifestyle

Table 11: The Distribution of the Frequency of Maintaining Healthy Lifestyle across WHO Additional Standard

The frequency of maintaining healthy lifestyles (self-perception)	Had Met WHO Additional Standard (%)	Had not met the WHO Additional Standard (%)
All the time	16	23
Mostly	36	39
Sometimes	39	33
Never	7	3
	100%	100%

There is no significant difference in the frequency of maintaining healthy lifestyle across the WHO general standard. However, some differences has been found across the WHO additional standard as shown in table 8. Participants who had met the WHO additional standard generally are less likely to maintain healthy lifestyles. There are only 16% reported they maintain healthy lifestyle very often compared with 23% participants who had not met the WHO additional standard reported they maintain healthy lifestyle very often.

3. The association between physical activity and work productivity

3.1 Do participants who had met the WHO Standards have a higher work productivity?

I tested if those who had met the WHO standard as well as the WHO additional standard are less likely to lose work efficiency because of health problems. According to the result shown in

table 9, the incident rate ratio of having a higher presenteeism between those who had met the WHO standard and who had not is 1.28 (p=0.10) and the incident rate ratio of having a 10% higher presenteeism between those who had met the WHO additional standard and who had not is 1.26 (p=0.18). There is no significant association has been found between presenteeism and WHO standards.

Further occupation type specified association between presenteeism and WHO standards has been explored. For office workers, the odds ratio of having a medical absence is 0.95 (p=0.86) and for labor workers, the incidence rate ratio is 1.63 (p=0.36) at the general WHO standard. For office workers, the odds ratio of having medical absence is 1.18 (p=0.37) and for the labor workers, the odds ratio of having medical absence is 0.88 (p=0.60) at the additional WHO standard.

Table 12: the Association between Presenteeism and WHO Standards

Number of Observation: 928 Prob>chi2=0.000					
	IRR	P-value		IRR	P-value
WHO Standard	1.26	0.18	WHO Additional Standard	1.28	0.1
Age		0.74	Age		0.72
Gender		0.3	Gender		0.26
Child		0.02	Child		0.03
Residence		0.1	Residence		0.05

Using the Logistic Model, I tested if those who had met the WHO standards are less likely to be absent from work because of medical conditions. According to table 10, results show that the odds ratio of having medical absence between those who had met the WHO standard and who had not is 1.48 (p=0.27). And the odds ratio of having medical absence between those who had

met the additional WHO standard and who had not is 2.51 (p=0.00) meaning that the odds of having medical absence among participants who had not met the WHO additional standard is 2.5 time as high as the odds of medical absence among participants who had not met the WHO additional standard. The Poisson model has been used in the sensitivity analysis which confirmed the results in the Logistic Model.

Further occupation type specified association between absenteeism and WHO standards has been explored. For office workers, the odds ratio of having a medical absence is 1.24 (p=0.58) and for the labor workers, the incidence rate ratio is 1.28 (p=0.70) at the general WHO standard. For office workers, the odds ratio of having medical absence is 2.08 (p=0.04) and for the labor workers, the odds ratio of having medical absence is 1.87 (p=0.28) at the additional WHO standard.

Table 13: The association between the absenteeism and WHO standards

Number of Observation: 928 Likelihood-ratio test of alpha=0: P<0.05					
	Odds Ratio	P value		Odds Ratio	P value
WHO Standard	1.48	0.27	WHO Additional Standard*	2.51	0.00*
Age		0.18	Age		0.14
Child		0.24	Child		0.00
Residence		0.06	Residence		0.12
Gender		0.04	Gender		0.05
* The result is significant in the sensitivity analysis					

3.2 Will More Physical Activity Lead to Higher Work Productivity?

According to table 10 below, with the increase of physical activity, employees do not become less likely to have medical absence (OR=1.001, p-value= 0.01). Even though the odds ratio is larger than 1, considering that the physical activity is measured in minute, the different is not trivial. It indicates that with every minute increase of physical activity, the odds of having medical absence increase 0.1%. Besides that, there is no significant association that has been found between the physical activity and the presenteeism (IRR=1.00, P=0.77).

Table 14: The association between work productivity and absenteeism

Number of Observation: 927 Likelihood-ratio test of alpha=0: P= 0.05				
	Absenteeism		Presenteeism	
	Odds Ratio	P value	IRR	P value
Total Physical Activity Time*	1.001	<0.05*	1.000	0.77
Age		0.4		
Gender	1.84	0.03		
Residence		0.32		
Child		0.12		

Furthermore, I tested the association between the healthy lifestyle and work productivity. The incidence rate ratio of presenteeism between participants who maintain healthy lifestyle all the time and participants who never maintain healthy lifestyle is 2.79 (p=0.06). As shown in table 13, there is a trend that the more frequently participants maintain healthy lifestyle, the less work efficiency will be impaired by health problems. As for the absenteeism, the more frequently

participants maintain healthy lifestyle, the less likely he/she will have medical absence. The odds ratio of medical absence between participants who maintain healthy lifestyle all the time and who never maintain healthy lifestyle is 2.18 (p=0.03) which indicates the odds of having medical absence among participants who never maintain healthy lifestyle is 2.18 times as high as the odds of medical absence among participants who keep healthy lifestyle all the time.

With the increase of the time spent on physical activities, the value of absenteeism increases much more among office workers than among labor workers while the value of presenteeism stays insignificant (p>0.05).

Table 15: The association between work productivity and healthy lifestyle

sample size P-value<0.05				
	Presenteeism		Absenteeism	
Health Lifestyle	Odds Ratio	p-value	Odds Ratio	p-value
Maintain Healthy Lifestyle All the Time	1		1	
Maintain Healthy Lifestyle Mostly	1.76	0.01	0.8	0.12
Maintain Healthy Lifestyle Sometimes	1.88	0.07	1.35	0.25
Never Maintain Healthy Lifestyle	2.79	0.06	2.18	0.03
Age		0.63		0.31
Gender		0.35		0.1
Child		0.80		0.16
Residence		0.33		0.08
Occupation Type		0.27		0.32

Discussion

The prior reason for the counterintuitive results from the study might be the physical injuries. For those who are more physically active, they have more chance of getting physical injuries during work, recreation and transportation, thus increasing the probability of having medical absence from work. However, the injury status is not measured in the survey. For the future studies, the status of injury should be collected directly in order to understand if those who had met the WHO additional standard are more likely to get injured.

Secondly, the association could be caused by the reverse causality- participants who had worse health status because of physical inactivity, have lower medical absences. This might be due to the tradeoff between economic income and leisure time. The labor leisure tradeoff is an economic theory, meaning that "a higher wage entices people to spend more time working, which entails a positively sloped labor supply curve" [22].In the study, participants who had not met the WHO additional standard are more likely to be employees with higher average wages $4,000-4,999 and larger residency, and they are more willing to trade leisure time for work. However, participants who had met he WHO additional standard have lower incomes, thus less willing to trade leisure time for work and more likely to have medical absences when needed

Thirdly, higher work productivity depends on forming a regular healthy lifestyle instead of only having intensive physical activities. The results show that the more frequently participants keep healthy lifestyle, the higher work productivity they will have. So far there is no clear definition of healthy lifestyle, but generally it includes adequate sleep, sufficient nutrition, regular physical activity, relieving mental pressure timely, and not smoking or drinking in excess. Physical activity is one of many important indicators of healthy lifestyle. Those who had not met the WHO additional standard in this study, from a social economic perspective, are more likely to have less income, lower education and being a labor worker which may constrain them from

mental health relieving services and balanced nutrition for example. Even though more physically active, they can hardly form a frequent healthy lifestyle. In order to promote healthy lifestyle, according to the study result, companies should assist employees forming a frequent healthy lifestyle instead of focusing only on promoting physical activities.

Fourthly, most of Singaporean employees do not ask for medical absence frequently, unless there is an urgent and serious medical condition. According to a Singapore local media, the Sunday Times Newspaper, employees asked only for about four days of their outpatient medical absence each year. However, by law, Singapore employees are given 14 days annual medical leaves [23]. Furthermore, most of the "urgent and serious medical condition", that may lead to medical absence, such as serious influenza, injuries and cancers, are caused by safety issues, influenza bacteria, and living environment, rather than physical inactivity, therefore we cannot observe a decrease in medical absence with the increase of physical activity as we hypothesized.

There are several limitations of this project. First is the report bias, that the actual time spent on physical activity is biased from the reported time spent on physical activities, and the reported time of medical leaves may not be the actual time of medical absences. In the future, we will use the recorded time of physical activity and medical absence to explore the association. Second is the selection bias, participants who attended the research are approached via the research company, leaving severely sick and injured employees not able to participate.

As a conclusion, based on the results, full time employees in Singapore who spent more time on physical activities is not less likely to have medical absences from work. Therefore, meeting the WHO issued physical activity standards is not associated with higher work productivity.

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